NP about Blue Light from CN-NC vs IEC TR 62778:2014

2017.09.06

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2. IEC TR 62778:2014
3. Similarities and Differences
1.1 NP ABOUT BLUE LIGHT FROM CN-NC

- **Background**
  - Full title: Measuring methods of blue-light characteristics and related optical performances for visual display terminal
  - Proposed by: CN-NC

- **Scope**
  - This document specifies measuring methods which contain blue-light characteristics and optical performances of visual display terminal, such as computer monitor, TV, etc.

  Note 1: This document is taken IEC 62471:2006 Photobiological safety of lamps and lamp systems as normative reference
  Note 2: This document is providing measurement methods only

1.2 MEASUREMENT METHOD

- **Measurement object**
  - Performance of visual display terminal

- **Measurement environment(s)**
  - Performed in dark room
  - Temperature: 15°C ~ 35°C
  - Humidity: 20 %RH to 80 % RH
  - Atmospheric pressure: 86 kPa to 106 kPa

- **Measurement Methods**
  - Measurement distances
    - Mobile display terminal: 30 cm
    - Computer monitor: 50 cm
    - TV: 3 x TV screen high
  - Step 1: Select 9 measurement points on visual display terminal
  - Step 2: Get L_b for each measurement
  - Step 3: Calculate L_B for each measurement points
  - Step 4: Calculate B_R for each measurement points
  - Step 5: Get each average values of L_b, L_B and B_R
1.3 CRITICAL FORMULAS

Formula 1: Blue-light radiance
\[ L_b = \int L_\lambda \cdot \Delta \lambda \]
- \( L_\lambda \) — Spectral radiance W·m\(^{-2}\)·nm\(^{-1}\)·sr\(^{-1}\)
- \( \Delta \lambda \) — Wavelength bandwidth nm

Formula 2: Blue-light weighted radiance
\[ L_B = \int L_\lambda \cdot B(\lambda) \cdot \Delta \lambda \]
- \( L_\lambda \) — Spectral radiance W·m\(^{-2}\)·nm\(^{-1}\)·sr\(^{-1}\)
- \( B(\lambda) \) — Weighted blue light hazard function
- \( \Delta \lambda \) — Wavelength bandwidth nm

Formula 3: Blue-light weighted radiance per luminance
\[ B_R = \frac{L_B}{L} \]
- \( L_B \) — Blue light weighted radiance W·m\(^{-2}\)·nm\(^{-1}\)·sr\(^{-1}\)
- \( L \) — Luminance cd·m\(^{-2}\)

Note: The \( B_R \) value is higher, the damage of display products is greater; the \( B_R \) value is lower, the damage of the display products is smaller.

2.1 IEC TR 62778:2014

Background
- Full title: IEC TR 62778:2014 Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaires
- Published by: IEC TC34 Lamps and related equipment

Scope
- This Technical Report brings clarification and guidance concerning the assessment of blue light hazard of all lighting products which have the main emission in the visible spectrum (380 nm to 780 nm). By optical and spectral calculations, it is shown what the photobiological safety measurements as described in IEC 62471 tell us about the product and, if this product is intended to be a component in a higher level lighting product, how this information can be transferred from the component product (e.g. the LED package, the LED module, or the lamp) to the higher level lighting product (e.g. the luminaire).

Note 1: IEC 62471:2006 Photobiological safety of lamps and lamp systems
Note 2: IEC 62471-2006 is published by IEC TC76 Optical radiation safety and laser equipment
Note 3: IEC 62471:2006 is a comprehensive horizontal standard, describing all potential health hazards associated with artificial optical radiation, from the ultraviolet, visible, and infrared portions of the spectrum
Note 4: IEC TR 62778:2014 is deals exclusively with the hazard described in 4.3.3 and 4.3.4 of IEC 62471:2006

Change life with heart
2.2 MEASUREMENT METHODS

- Measurement object
  - Performance of LED point light source
- Measurement environment(s)
  - Standard measurement conditions
- Measurement Methods
  - Starting with $d = 20$ cm & FOV (Field of viewing) = 0.011 rad
  - Case 1: Source image underfill
    - Perform method 1: to obtain $L_B$
  - Case 2: Source image overfill
    - Reduce FOV angle only to make case 1 feasible, then get $L_B$
    - Or performing irradiance measurement with distance $d = 20$ cm, to get $E_B, E_{thr}, d_{min}$

2.3 CRITICAL FORMULAS

- Formula 1: Blue light weighted radiance / irradiance
  $$ \phi_\lambda = \int \Phi \cdot B(\lambda) \cdot d\lambda $$
  - $\Phi$ — Spectral radiance $W \cdot m^{-2} \cdot sr^{-1}$ / irradiance $W \cdot m^{-2}$
  - $B(\lambda)$ — Weighted blue light hazard function
  - $\Delta \lambda$ — Wavelength period
  - $K_{B,v}$ — Blue light hazard efficacy $W \cdot lm^{-1}$

- Formula 2: Threshold illuminance
  $$ E_{thr} = E_B / K_{B,v} \left( \frac{W}{W} @ 1W \cdot m^{-2} \cdot sr^{-1} \right) $$
  $$ k_{dmin} = \frac{\int \Phi \cdot B(\lambda) \cdot d\lambda}{K_{B,v} \cdot \int \Phi \cdot V(\lambda) \cdot d\lambda} $$
  - $k_{dmin}$ — 683 $lm \cdot W^{-1}$
  - $\Phi$ — Can be replaced by $L_B W \cdot m^{-2} \cdot sr^{-1}$ / $E_B W \cdot m^{-2}$

- Formula 3: $d_{min}$ derivation
  $$ d_{min} = \left( \frac{I \cdot \cos^2 \alpha}{E_{thr}} \right)^2 $$
  - $I$ — Intensity of the source into the direction of the position where $E_{thr}$ is evaluated
  - $d_{min}$ — Minimal distance for the source to the position
  - $\alpha$ — Angle between the light and the normal of the plane in which $E_{thr}$ is determined

Figure 3-Method 1 measurement demo
Figure 4-Method 2 measurement demo
Figure 5-Illustration for formula 3
### 3.1 METHODS FOCUSED COMPARISON

<table>
<thead>
<tr>
<th>Methods Focused</th>
<th>NP from CN-NC</th>
<th>IEC TR 62778:2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normative References</td>
<td>Both adopted IEC 62471:2006</td>
<td></td>
</tr>
</tbody>
</table>

#### Measurement Object
- Visual display terminal
- LED point light source

#### Measurement Environment(s)
1. Performed in darkroom
2. Temperature: 15ºC ~ 35 ºC
3. Humidity: 20 %RH to 80 %RH
4. Atmospheric pressure: 86 kPa to 106 kPa

#### Measurement Methods

- Specified fixed measurement distances
  - Case 1: Mobile display terminal: 30 cm
  - Case 2: Computer monitor: 50 cm
  - Case 3: TV: 3 x TV screen high
- Average values for selected 9 points of L, L<sub>B</sub> & R<sub>B</sub>

1. Underfill: Measuring L<sub>B</sub> with FOV = 0.011 rad and distance = 20 cm
2. Overfill:
   - Case 1: Measuring L<sub>B</sub> with FOV = 0.011 rad and distance = adjusted
   - Case 2: Measuring L<sub>B</sub>, E<sub>B</sub>, d<sub>min</sub> for distance = 20 cm

#### Calculating Formulas
1. Blue-light radiance
2. Blue light weighted radiance
3. Blue-light weighted radiance per luminance
4. Blue light weighted radiance / irradiance
5. Threshold illuminance
6. d<sub>min</sub> derivation

#### Other Optical Properties Measurements?
- Yes
- NO

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### 3.2 OBJECT FOCUSED COMPARISON

<table>
<thead>
<tr>
<th>Object Focused</th>
<th>NP from CN-NC</th>
<th>IEC TR 62778:2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Object</td>
<td>Visual display terminal</td>
<td>LED point light source</td>
</tr>
</tbody>
</table>

#### Object Definitions

- DIRECTLY WATCHING purpose
- Display performances
- Directional area light source

#### Application Scenario
- Mobile, monitor, TV, etc.
- Signal light, desk lamp, room light, etc.

#### Way to affect the eye
- Directly LONG TIME watching

#### Summary:
- From this slide, it is clearly that the product of visual display terminal and LED point light source are based on two entirely different concepts
3.3 CONCLUSION

- The measurement objects, environments, methods and calculation formulas are totally different between NP about Blue Light from CN-NC and IEC TR 62778:2014

- Based on all evidences illustrated just before, the measurement methods of IEC TR 62778:2014 are not feasible for measuring visual display terminal. Therefore, NP about Blue Light from CN-NC is pretty critical

4.1 BRIEF OF MEASUREMENT METHOD

- Measurement tool: Spectral radiance meter
- Testing signal: All white field signal
- Testing Samples: 8 mobile phones with eye-protection mode (all different famous brands)
  - Screen sizes are about 5.5 inches
- Formula of blue light weighted radiance $L_B$ (Adopted with IEC 62471:2006):
  \[
  L_B = \sum_{\lambda=300}^{700} (L_\lambda \cdot B(\lambda) \cdot \Delta\lambda)
  \]
- $L_\lambda$ —— Spectral radiance;
- $B(\lambda)$ —— Blue light hazard weighting function;
- $\Delta\lambda$ —— Wavelength period.
## 4.2 TESTING RESULTS

### Parameters under eye-protection mode enabled (luminance: 120 cd/m²):

<table>
<thead>
<tr>
<th>Samples</th>
<th>Original Luminance cd/m²</th>
<th>Eye-protection Mode Luminance cd/m²</th>
<th>Original Blue Light Weighted Radiance w/m²·sr⁻¹</th>
<th>Eye-protection Mode Blue Light Weighted Radiance w/m²·sr⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>124.3</td>
<td>106.2</td>
<td>2.15</td>
<td>0.483</td>
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<tr>
<td>B</td>
<td>119.6</td>
<td>76.6</td>
<td>2.40</td>
<td>0.993</td>
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<tr>
<td>C</td>
<td>121.3</td>
<td>90.6</td>
<td>2.33</td>
<td>1.06</td>
</tr>
<tr>
<td>D</td>
<td>120</td>
<td>96.7</td>
<td>2.19</td>
<td>1.26</td>
</tr>
<tr>
<td>E</td>
<td>118.3</td>
<td>100.2</td>
<td>2.21</td>
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<td>F</td>
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<td>1.45</td>
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<tr>
<td>G</td>
<td>125</td>
<td>109.9</td>
<td>2.36</td>
<td>1.49</td>
</tr>
<tr>
<td>H</td>
<td>123.6</td>
<td>112.1</td>
<td>2.04</td>
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</table>

Summary:
- The blue light radiance decreases under eye-protection mode enabled
- Sample A got the lowest blue light radiance after eye-protection mode enabled

### Parameters under eye-protection mode enabled (the Lowest brightness status):

<table>
<thead>
<tr>
<th>Samples</th>
<th>Original Luminance cd/m²</th>
<th>Eye-protection Mode Luminance cd/m²</th>
<th>Original Blue Light Weighted Radiance w/m²·sr⁻¹</th>
<th>Eye-protection Mode Blue Light Weighted Radiance w/m²·sr⁻¹</th>
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</thead>
<tbody>
<tr>
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<td>2.2</td>
<td>1.7</td>
<td>3.84</td>
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<tr>
<td>B</td>
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<td>1</td>
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<tr>
<td>C</td>
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<td>1.5</td>
<td>2.72</td>
<td>1.81</td>
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<tr>
<td>D</td>
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<td>1.6</td>
<td>3.92</td>
<td>2.47</td>
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<td>3.6</td>
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<td>7.23</td>
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<tr>
<td>G</td>
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<td>H</td>
<td>6.7</td>
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</table>

Summary:
- The blue light radiance decreases under eye-protection mode enabled
- Sample A got the lowest blue light radiance after eye-protection mode enabled
Thanks!